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ASTRO-COMMUNICATIONS BRANCH
ASTRO-ELECTRONICS DIVISION
COMMUNICATIONS DEPARTMENT
U. S. ARMY SIGNAL RESEARCH AND DEVELOPMENT LABORATORY

1 February 1960

SUBJECT: Monthly Progress Report (1 Jan - 31 Jan 60) on ARPA Order No. 33-60, Delayed Repeater Satellite Communication System, Project Courier (U)

TO: Director
Advanced Research Projects Agency
Washington 25, D. C.

1. (U) This monthly report is submitted in accordance with instructions contained in Amendment No. 2 (Attachment No. 1) to ARPA Order No. 33-59, dated 1 Apr 59.'

2. (C) Narrative Summary: Satisfactory funding for this fiscal year has not yet been established. Visits made to contractors and subcontractors during the month indicate that work on all phases of the Courier system is progressing except that effort has been reduced to permit the contractors to function as efficiently as possible in the face of funding shortages and the possibility of work stoppage. Schedules have been established for delivery of the ground antenna towers to each of three sites; detailed information has been prepared in connection with the Puerto Rican site and construction at this location is continuing in a satisfactory manner. Official authorization to implement the second site has not been received.

3. Specific activities during Jan 60 follow:

a. Technical Status

(1) Visits to contractors during the month included:

(a) (U) 14-21 Jan, Philco WDL, Palo Alto: Review of progress covered the effort on the satellite structure, thermal design results, electronic components and the microwave antenna design. A detailed report on results of antenna pattern measurements is included as supplementary information to this report (Incl 1). Subcontractor effort on the tape recorder work was also reviewed and preliminary test results indicate that specification requirements will be met. A microwave receiver prototype was delivered from Philco, Philadelphia, where the receiver work, as well as other microwave components, is being conducted. A breadboard model of the microwave diplexer unit was also received, however this model appeared to require extensive rework before acceptance. Performance of the units could not be assessed during this visit due to tuning mechanism alignment difficulties. Nickel-cadmium batteries designed for Courier are currently undergoing life test at Sonotone Co.

(b) (U) 18 Jan 60, ITTL: Work on this contract has been reduced to permit the contractor to function in the face of funding shortages and the possibility of work stoppage. Aspects of the work reviewed included progress on all electronic components being fabricated at ITTL plus all subcontractor effort. Several approaches are being investigated for the parametric receivers to optimise the required tuning range and noise figure. Final design of the "X" band pump oscillator is nearing completion. Work is continuing on all major component items. Those released for fabrication include, the frequency multiplier unit of the UHF receiver, 70 mc gaussian filters, IF amplifiers, post IF amplifiers, and the demodulator-combiner. Completion of the 1 KW UHF amplifiers awaits delivery of the Varian 802 klystrons which are expected momentarily. Effort at Adler Electric Corp. (subcontractor for the van installation) has been reduced to a level commensurate with available funds. No overtime work was accomplished during this month. Results of this reduction in effort will be reflected as delay in the delivery of the equipment being procured from ITTL.

(c) (U) 18-22 Jan, Radiation Inc: Primary purpose of this visit was to review all antenna feed and rotary joint work and servo system design. The design and development phase of the VHF antenna feed has been completed and further effort must await finalization of the microwave feed, now being designed. Detail design of the shelter, cabling, console and individual chassis is approaching completion. Fabrication of these components was started 15 Dec 59 and work is continuing at a rate consistent with present delivery schedules.

(d) (C) 12-26 Jan, D. S. Kennedy (subcontractor to Radiation for tower and reflectors): Present effort is directed toward completion of the fabrication of Tower No. 1 (Puerto Rican installation) with the following work remaining to be accomplished: installation of slip-ring assembly, completion of dash-pot assembly, mounting of AZ-EL turret, completion of spar fabrication, and wiring of all electrical units. A final system assembly on Tower No. 1 should be completed by 1 Feb 60 with component and system testing scheduled for completion by 9 Feb. The anticipated delivery schedule for Tower No. 1 is as follows:

15 Feb 60 - available for shipment at D. S. Kennedy, Cohasset, Mass.

23 Feb 60 - delivery to the site at Camp Salinas, Puerto Rico

5 Mar 60 - erection work completed, on-site acceptance testing started

Tower No. 2 originally scheduled for installation at Torrejon AFB, Madrid, will be ready for shipment from D. S. Kennedy on or about 1 Mar 60. Radiation Inc. has informed USASRDL that in the event this equipment cannot be shipped in the 12 Feb to 13 May 60 period, increased costs will be incurred due to rescheduling, redeployment of personnel, and storage of the unit. Tower No. 3, scheduled for installation at the Hawaiian site, will be ready for shipment about 1 Apr 60. Arrangements are being made to store this equipment at the Sacramento Signal Depot pending final disposition.

(2) (U) A meeting held at USASRDL with ITTL and Radiation Inc. resolved interface areas between the ground station equipment and the tracking antenna equipment. It was mutually agreed that the RF components being bulit by Radiation Inc. would not be installed at the Puerto Rican site until compatibility tests have been performed at ITTL to determine the acceptability of these components from the standpoint of power-handling capacity (1 KW) and noise power measurements using the ITT low-noise parametric receivers and transmitters. An estimated date of 1 Mar 60 appeared reasonable for these tests. Further agreements concerned the level of tracking signals to be provided to the servo system by ITTL, requirements for the recording of angular position data, and panel light coding system differences between the prime ITTL gear in the operations van and the Radiation-supplied antenna remote control console.

(3) (C) At the Camp Salinas site, preparation work has been completed and the concrete tower foundation is ready for installation of the D. S. Kennedy tower. A security fence and bore-sight tower have also been installed. Installation work is expected to begin in Puerto Rico approximately 15 Feb 60 and arrangements are currently in progress to provide for water transportation of the towers for this site.

(4) (C) In order to economically utilize the scheduled manpower for the installation at the second site, work must proceed not later than 12 Feb 60. Any deviations from this schedule will result in increased costs for re-scheduling, redeployment of personnel, storage of equipment, and a possible conflict with fabrication and installation of the third ground station in Hawaii.

b. Problems Encountered

(1) (C) No action can be taken to implement the second site until official authorization to proceed has been received.

(2) (U) Rearrangement of funding schedule necessary to fund contracts through completion to avoid work stoppages, delays and increased costs.

c. Work Schedule

(1) (U) Courier steering committee meeting will be held during Feb 1960 at USASRDL

(2) (U) Visits to contractors and subcontractors will be continued.

(3) (C) In-plant system compatibility tests between a functional satellite, a ground station, and a checkout van will be conducted at ITTL.

(4) (C) Radiation Inc. will perform system tests on the ground antenna system in Puerto Rico in Mar 60 using available equipment.

(5) (U) Schedules for completion of work on towers for all three sites is noted in Par 3.a.(1)(d) above.

d. Action Required by ARPA

(1) (U) Providing USASRDL with sufficient funding to prevent work stoppages at contractors' plants and attendant problems.

(2) (U) Decision on the Second Courier site.

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Prepared by: Peter T Maresca.
~~PETER T. MARESCA~~
Chief, Astro-Communications Branch

Approved by: DL Jacoby
~~SAMUEL P. BROWN~~
Director, Astro-Electronics Division

1 Incl
Measurement Rpt

MEASUREMENT OF FIN ANTENNA 16 January 1960

by Donald H. Marx and John Cittadino
U. S. Army Signal R & D Laboratory
Fort Monmouth, New Jersey
for Contract DA 36-039 SC-78958

1. **Description of Test**

The test consisted of making measurements of received signal level at 10 degree increments over the hemisphere on which the Philco developed fin antenna is centered. A figure below gives the essentials of the test set-up employed. Measurements were effected by placing the fin structure at a given angle with respect to zenith and rotating the azimuth through 180 degrees in 10 degree steps. Each condition was measured with the source both horizontally and vertically polarized. The sphere was oriented for two general series of readings thereby giving redundant data. This is explained in the discussion of the co-ordinate system used.

2. **Co-ordinate System**

When looking from the source of radiation towards the sphere with the fin antenna, the following notation applies:

Elevation: Zero elevation corresponds to the fin pointing skyward along the zenith axis. 90 degrees corresponds to the fin pointing parallel to the ground.

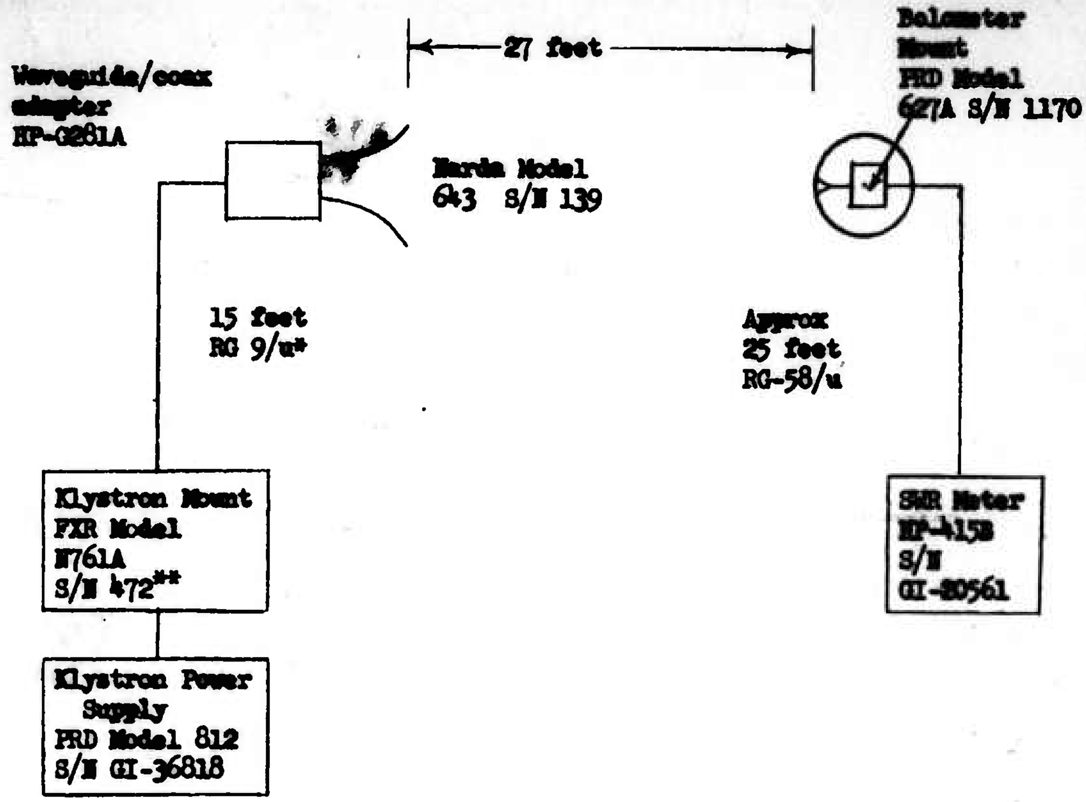
Azimuth: 90 degree azimuth corresponds to the fin pointing towards the radiating source when the elevation is also 90 degrees. At 0 degree azimuth and 90 degree elevation the fin is to the left when viewed from the radiating source. Accordingly, at 180 degree azimuth and 90 degree elevation the fin is seen on the right side of the sphere when viewed from the radiating source.

Measurements using this co-ordinate system were made with the radiating source horizontally and vertically polarized and with the fin horizontally and vertically polarized. Reference for the fin polarization is taken when both azimuth and elevation is at 90 degrees.

3. **Test Equipment and Set-up**

The following sketch gives the test equipment and set-up employed. All facilities were supplied by Philco Corporation at their 3875 Fabian Way, Palo Alto, California, plant. Serial numbers refer to either the test equipment manufacturer's number or the Philco number as indicated by a GI prefix to the Philco numbers.

Incl 1



*To determine frequency an HP 806B slotted line with an HP 442B probe and an HP 440A detector was inserted at output of Klystron mount and coupled by approximately 4 feet RG-58/u cable to HP-415B SWR meter.

**Sperry 2K43 klystron used.

Standard conditions applying to the measurement follow:

1. Frequency: 4.69 kmc/s

2. Detector settings (HP 415B):

   a. Low range

   b. 200 Ω bolometer

3. Klystron Power Supply Settings:

   a. Beam voltage: 1250V

   b. Reflector voltage: 370V

c. Grid voltage: 0V approx.

d. Modulation selector: grid

e. Modulation type: square wave

f. Modulation amplitude: 77V approx.

g. Modulation frequency: optimized on HP-415B ($\approx$1000 c/s)

h. Beam current: 35 MA

i. Grid calibration: 1/10 division high*

j. Reflector calibration: 2/10 division high*

k. Meter reading of beam voltage: 1300V

4. Ambient noise: $\approx$ 70 db. Levels of 65 db were observed occasionally and weak measurements were not made at that time.

4. <u>Definitions of Measurements</u>

With the fin antenna oriented at 90 degree elevation and 90 degree azimuth, the following measurement definitions apply:

Case 1: Source is horizontally polarized
Fin is horizontally polarized

Case 2: Source is vertically polarized
Fin is horizontally polarized

Case 3: Source is horizontally polarized
Fin is vertically polarized

Case 4: Source is vertically polarized
Fin is vertically polarized

5. <u>Gain Reference</u>

Lacking a gain calibrated antenna, a 2 X 2 foot sheet of aluminum with an RG-49/u waveguide to coax adapter was employed to establish a gain reference for the system. Maximum level and half power levels were recorded in both planes for this broadly directional slot antenna.

*One division $\doteq$ 500 volts on meter beam voltage calibration.

6. <u>Gain Reference Data</u>

Case 1 - Radiating Source and Slot antenna Horizontally polarized (E plane pattern)

Condition	Level	Azimuth
Maximum level	48 db	93 degrees
Half power level	51 db	149 degrees
Half power level	51 db	40 degrees

Case 2 - Radiating Source and Slot antenna Vertically Polarized (H plane pattern)

Condition	Level	Azimuth
Maximum level	48 db	94 degrees
Half power level	51 db	61 degrees
Half power level	51 db	125 degrees

7. <u>Gain Computation</u>

An approximate formula, capable of approximating side lobe contributions, but neglecting losses in the system is employed to estimate the gain

$$Gr' = K \frac{40{,}000}{\beta e\,\beta h}$$

where Gr' = receiving antenna gain (ratio)

βe = E plane beam width in degrees

βh = H plane beam width in degrees

K = A fraction relating the equivalent solid angle coverage of an antenna to the half power beamwidths.

$$\beta e = 149 - 40 = 109 \text{ degrees}$$

$$\beta h = 125 - 61 = 64 \text{ degrees}$$

$$K \approx 3/4 \,*$$

$$Gr' = \frac{3/4 \cdot 40{,}000}{109 \cdot 64} = 4.3 \text{ (ratio)}$$

$$Gr = 10 \log Gr'$$

$$= 10 \log 4.3 = 6.3 \text{ db}$$

*An estimated value

Verbally presented Philco information indicated a measured gain of 7 db in lieu of the figure stated above.

8. Gain Adjustment

The slot antenna level corresponded to a minus 48 db reading. Assuming a 6 db gain for the slot antenna, a 54 db reading in the following data corresponds to isotropic level. If the Philco figure of 7 db is used a 55 db reading corresponds to isotropic.

9. Effect of tuner

In an effort to evaluate the loss resulting from mismatch of the bolometer and the feed, a double stub tuner was added between the bolometer and the antenna feed for both the fin and the slot antennas. Using horizontal polarization the following data resulted.

Antenna	Tuner	Level
slot	no	49.0
slot	yes	49.5
fin	no	60.7
fin	yes	58.5

Both antennas were operated in 90° azimuth and 90 degree elevation conditions.

10. Fin Antenna Measured Data

The following tables give the raw data measured on the fin antenna.

HORIZONTAL SOURCE - HORIZONTAL FIN

Case 1

ELEVATION	0	10	20	30	40	50	60	70	80	90
AZIMUTH										
0	68.4	65.2	61.0	57.6	55.2	53.0	52.0	51.4	50.4	50.9
10	68.9	66.6	62.2	58.0	55.1	53.0	52.4	50.6	50.4	50.0
20	64.0	64.4	61.6	59.5	57.2	54.8	53.2	51.6	50.9	50.4
30	61.4	60.0	59.5	58.5	56.6	55.1	54.2	52.4	52.0	52.4
40	58.4	57.2	56.6	56.5	56.0	55.1	54.8	53.0	52.4	52.8
50	58.2	56.0	55.2	54.7	54.3	53.6	53.0	53.0	52.4	51.8
60	58.4	55.8	54.4	53.6	53.2	53.4	53.0	53.0	52.8	52.4
70	58.6	56.0	54.0	53.2	53.2	53.4	53.6	53.2	53.2	53.4
80	58.4	55.8	53.4	53.0	53.0	54.2	54.0	54.0	54.0	54.3
90	58.6	55.4	53.2	53.0	53.4	54.5	54.5	55.3	55.2	55.8
100	58.6	55.4	53.6	53.0	53.6	54.5	54.5	55.4	55.0	54.8
110	58.4	55.4	54.0	53.0	53.6	53.8	54.0	55.2	54.5	54.0
120	58.1	55.4	54.0	53.0	53.4	53.4	53.4	54.0	53.0	52.8
130	58.1	55.4	54.0	53.2	53.4	53.0	53.6	53.0	52.8	52.2
140	57.6	55.8	54.7	54.5	54.5	54.5	53.8	53.0	52.2	53.0
150	58.4	56.6	55.2	56.2	56.2	55.4	54.8	53.8	53.0	53.2
160	60.0	59.7	59.5	58.4	56.8	55.4	55.1	53.2	53.0	51.4
170	62.4	64.0	62.6	58.9	56.2	54.5	52.8	52.0	50.9	50.0
180	67.2	67.8	62.6	58.2	56.0	52.6	51.6	53.6	50.0	49.5

VERTICAL SOURCE - HORIZONTAL FIN

Case 2

ELEVATION	0	10	20	30	40	50	60	70	80	90
AZIMUTH										
0	52.6	52.0	53.0	53.2	54.2	56.0	58.4	62.4	70.0	70.0
10	52.4	52.4	52.2	52.8	53.6	55.1	56.6	60.0		
20	53.0	53.0	52.8	52.6	54.0	55.0	57.2	60.4		
30	54.8	54.0	53.8	53.8	54.0	54.7	57.2	60.6		
40	56.3	56.4	55.4	55.2	54.8	66.1	58.4	60.9		
50	60.0	59.5	57.8	57.6	57.8	57.8	59.5	61.6		
60	63.6	63.6	63.0	62.4	62.0	61.8	61.6	64.0		
70	68.1	68.3	68.4	67.8	65.4	64.7	64.8	65.5		
80	68.9	70.0	69.5	69.5	68.4	66.6	66.6	66.6		
90	68.9	70.0	70.0	70.0	70.0	69.5	68.9	67.8		
100	68.6	70.0	68.4	68.4	67.8	68.9	69.5	69.0		
110	67.8	67.4	66.0	66.0	66.0	66.6	68.9	69.0		
120	65.4	64.0	63.0	63.2	6[illegible].8	63.4	67.8	68.4		
130	62.0	60.6	60.0	60.0	60.0	60.0	63.6	66.0		
140	60.0	57.8	57.2	56.2	56.0	57.2	60.0	62.0		
150	56.6	56.0	55.2	54.7	54.5	55.0	57.2	59.0		
160	55.1	53.4	53.6	53.4	53.4	54.7	56.0	57.2		
170	53.2	52.2	52.4	53.0	53.6	54.8	56.0	57.2		
180	52.4	51.3	52.2	53.4	53.6	55.7	56.6	58.4		

HORIZONTAL SOURCE - VERTICAL FIN

Case 3

ELEVATION	0	10	20	30	40	50	60	70	80	90
AZIMUTH										
0	59.0	60.0	60.3	61.9	62.6	64.5	68.0	68.5	69.5	69.0
10	59.3	59.2	58.8	59.9	60.0	61.0	62.8	66.5	69.0	
20	59.5	58.2	57.5	58.1	58.3	58.2	61.0	66.0	68.5	
30	58.5	57.4	55.8	56.6	56.8	57.0	60.5	65.0	66.5	
40	58.8	56.5	54.7	55.0	55.7	56.5	60.0	65.5	66.5	
50	58.2	55.8	54.0	54.2	55.0	56.8	61.0	67.5	67.5	
60	59.7	56.5	54.4	54.1	55.0	57.5	62.0	69.0	69.0	
70	61.2	57.8	56.	55.0	56.2	59.5	65.5	69.5	69.5	
80	64.7	60.6	59.2	57.8	58.8	61.9	68.5	70.0	70.0	
90	68.5	67.0	65.7	63.4	64.5	66.5	69.5	70.0	70.0	
100	69.0	68.5	68.7	68.5	68.5	68.0	68.5	69.0	69.0	
110	65.5	64.3	61.8	62.0	62.8	64.5	65.2	68.0	69.0	
120	61.4	59.9	57.4	57.5	58.5	60.0	62.7	66.7	68.5	
130	60.0	57.2	55.4	55.3	56.1	58.2	60.5	65.5	68.5	
140	58.7	56.0	54.6	54.6	55.3	57.4	59.0	65.2	69.0	
150	58.5	56.2	55.0	54.8	55.6	57.2	59.5	63.6	68.5	
160	59.0	57.0	56.1	55.6	56.4	57.5	60.7	65.3	70.0	
170	59.2	57.7	57.8	57.2	57.8	59.5	61.8	66.5	69.5	
180	59.0	58.6	60.0	59.0	60.5	61.4	64.0	65.8	69.5	

VERTICAL SOURCE - VERTICAL FIN

Case 4

ELEVATION	0	10	20	30	40	50	60	70	80	90
AZIMUTH										
0	69.0	69.0	67.0	64.7	63.6	61.0	60.0	59.5	61.0	59.8
10	68.7	68.5	67.5	64.5	62.4	59.6	58.0	56.3	57.5	55.7
20	68.5	68.5	67.7	64.0	60.6	57.5	55.6	54.7	55.4	53.2
30	66.0	68.7	69.0	64.0	59.5	56.8	54.8	53.8	53.8	52.4
40	61.8	65.7	68.5	64.6	59.0	56.3	54.7	54.2	53.3	52.6
50	58.3	60.2	63.0	63.6	58.8	56.1	54.8	55.1	54.0	53.6
60	55.9	56.6	59.0	60.5	58.2	56.0	55.2	56.0	54.7	55.4
70	54.5	54.6	56.2	57.8	56.8	55.3	55.5	56.4	56.4	56.4
80	53.3	53.5	54.7	56.2	55.6	54.6	55.3	56.5	57.2	56.9
90	52.8	53.0	54.0	55.5	55.2	54.2	55.3	56.5	56.8	57.2
100	53.0	52.9	54.1	55.3	55.3	54.0	55.3	56.0	56.8	56.6
110	53.6	53.2	54.6	55.7	55.4	54.5	55.5	55.7	57.0	56.4
120	55.2	54.5	56.2	56.8	56.0	54.8	55.5	55.3	56.0	56.0
130	57.0	56.8	58.6	58.8	57.5	55.6	55.3	54.8	55.0	55.1
140	59.5	60.2	62.6	61.6	58.5	55.8	54.8	53.6	54.4	53.6
150	64.5	66.0	67.0	63.5	59.2	56.5	54.7	53.3	53.8	52.6
160	67.8	68.0	68.0	63.0	59.5	57.0	55.1	53.8	53.5	53.0
170	68.5	68.0	66.5	62.5	59.5	58.0	57.0	55.5	54.5	54.5
180	69.0	67.5	65.8	62.8	60.3	59.7	58.8	58.4	56.3	56.5

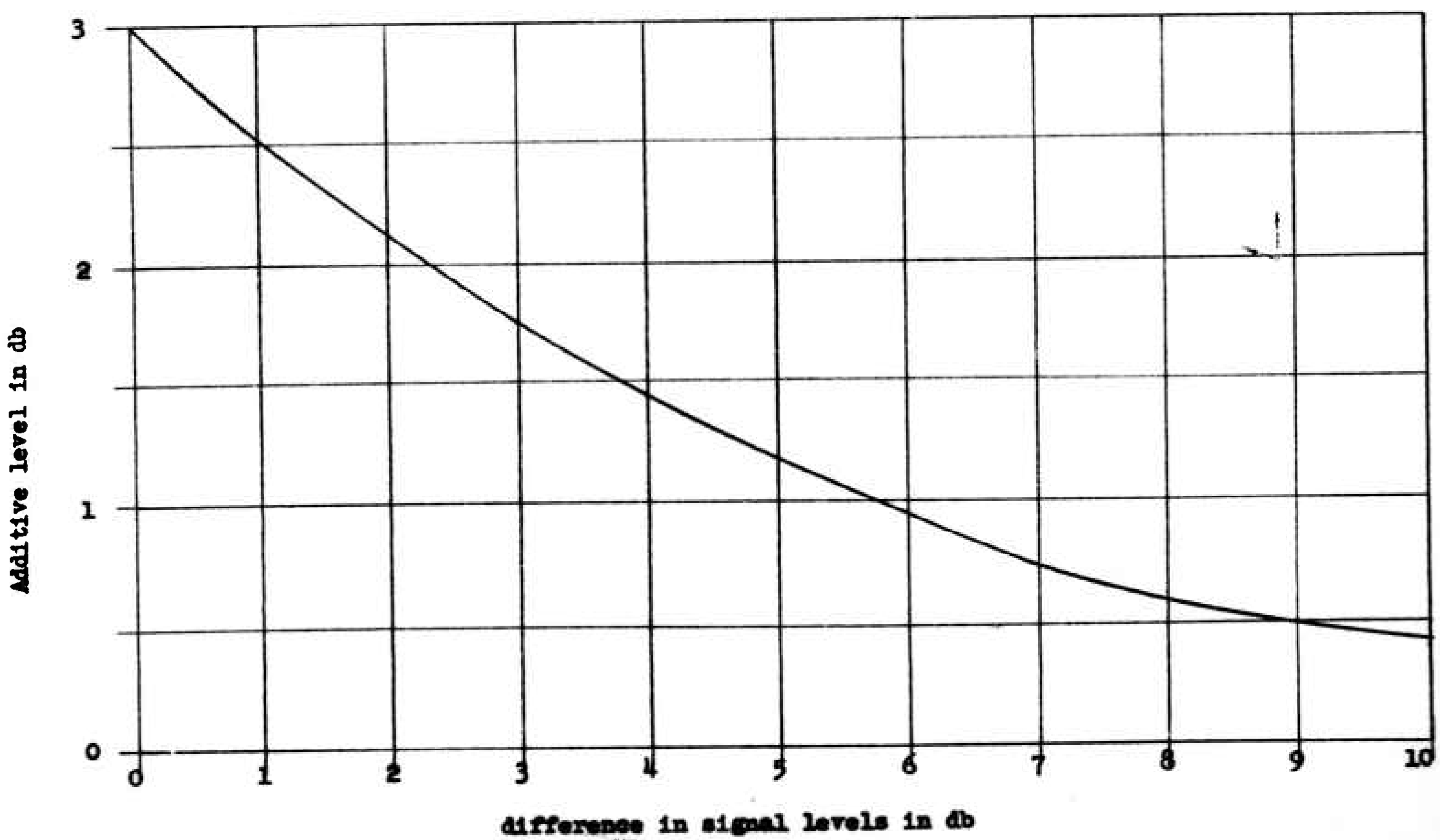
11. Computed Data

Assuming that the power received and transmitted through the fin antenna will be fed through orthogonal ground antennas during normal system operation, the performance of the fin antenna is appraised by addition of the case 1 and case 2 power levels followed by addition of the case 3 and case 4 power levels as a check. Since data has been expressed in db, the graph of page 11 is used to effect the power addition.

Graph of the signal level in db which must be added to the stronger of two signals to express the combined output level.

DONALD H. MARX
18 January 1960

USASRDL - ASTRO COMMUNICATION BR.
FORT MONMOUTH, N. J.



FIN ANTENNA MEASUREMENTS

Case 1 + Case 2

ELEVATION	0	10	20	30	40	50	60	70	80	90
AZIMUTH										
0	52.6	52.0	53.0	51.9	51.7	51.2	51.1	51.4	50.4	50.9
10	52.4	52.4	52.2	51.7	51.4	50.9	51.0	50.6	50.4	50.0
20	53.0	53.0	52.3	51.8	52.3	51.1	51.8	51.6	50.9	50.4
30	54.0	53.0	52.8	52.6	52.1	51.9	52.5	52.4	52.0	52.4
40	54.2	53.8	53.0	54.8	52.4	55.1	53.3	52.2	52.4	52.8
50	56.0	54.4	53.3	52.9	52.7	52.2	52.3	52.4	52.4	51.8
60	57.3	55.2	54.0	53.1	52.7	52.8	52.5	52.7	52.8	52.4
70	58.2	56.0	54.0	53.2	53.2	53.4	53.6	53.2	53.2	53.4
80	58.0	55.8	53.4	53.0	53.0	54.2	54.0	54.0	54.0	54.3
90	58.2	55.4	53.2	53.0	53.4	54.5	54.5	55.3	55.2	55.8
100	58.2	55.4	53.6	53.0	53.6	54.5	54.5	55.4	55.0	54.8
110	58.0	55.4	54.0	53.0	53.6	53.8	54.0	55.2	54.5	54.6
120	57.4	54.9	53.5	52.6	53.0	53.0	53.4	54.0	53.0	52.8
130	56.7	54.3	53.0	52.4	52.6	52.2	53.2	53.0	52.8	52.2
140	55.7	53.7	52.8	52.4	52.4	52.7	52.9	52.5	52.2	53.0
150	54.4	53.3	52.2	52.4	52.3	52.2	52.8	52.7	53.0	53.2
160	53.9	52.5	52.6	52.2	51.8	52.0	52.5	51.8	53.0	51.4
170	52.7	52.0	52.1	52.0	51.7	51.7	51.1	50.8	50.9	50.0
180	52.4	51.3	51.8	52.2	51.6	50.9	50.4	52.4	50.0	49.5

FIN ANTENNA MEASUREMENTS

Case 3 + Case 4

ELEVATION	0	10	20	30	40	50	60	70	80	90
AZIMUTH										
0	59.0	59.5	59.5	63.7	60.1	59.4	59.4	59.0	60.4	59.3
10	58.8	58.7	58.3	58.6	58.0	57.2	56.8	56.3	57.5	55.7
20	59.0	58.2	57.5	57.1	56.3	54.8	54.5	54.7	55.4	53.2
30	57.8	57.4	55.8	55.9	54.9	53.9	53.8	53.8	53.8	52.4
40	57.0	56.0	54.7	54.6	54.0	53.4	53.6	54.2	53.3	52.6
50	55.2	54.5	53.5	53.7	53.5	53.4	53.9	55.1	54.0	53.6
60	54.4	53.5	53.1	53.2	53.3	53.7	54.4	56.0	54.7	55.5
70	53.7	52.9	53.1	53.2	53.5	53.9	55.5	56.4	56.4	56.4
80	53.3	52.8	53.4	53.9	53.9	53.9	55.3	56.5	57.2	56.9
90	52.8	53.0	54.0	54.9	54.7	54.2	55.3	56.5	56.8	57.2
100	53.0	52.9	54.1	55.3	55.3	54.0	55.3	56.0	56.8	56.6
110	53.6	53.2	53.9	54.8	54.7	54.5	55.1	55.7	57.0	56.4
120	54.3	53.4	53.7	54.1	54.1	53.7	54.8	55.3	56.0	56.0
130	55.2	54.0	53.7	53.7	53.7	53.7	54.2	54.8	55.0	55.1
140	56.2	54.6	54.0	53.8	53.6	53.5	53.4	53.6	54.4	53.6
150	57.5	55.8	55.0	54.3	54.0	53.8	53.5	53.3	53.8	52.6
160	58.5	57.0	56.1	54.9	54.7	54.2	54.0	53.8	53.5	53.0
170	58.7	57.7	57.3	56.1	55.5	55.7	55.8	55.5	54.5	54.5
180	59.0	58.1	59.0	57.5	57.4	57.4	57.7	57.7	56.3	56.5

12. Conclusion

It is concluded that the ratio of the maximum to minimum response of the fin antenna, when operated in conjunction with an orthogonally polarised terminal is approximately 8.7 db. Due to the lack of a reference gain antenna, an exact relationship comparing observed levels with isotropic level was not established. It is estimated that the range of levels observed corresponded to ± 4 db with respect to isotropic.

It is also concluded that the fin antenna employed in these measurements does not match a 50 ohm system. Accordingly, additional work to improve the USWR of the antenna must be implemented before the design is suitable for Courier use.

VSWR

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